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DEVELOPMENT OF A CANADIAN FORCES QUICK DON ANTI-EXPOSURE IMMERSION SUIT

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ABSTRACT

This report details the development and testing of anti-exposure immersion suits to replace the current Canadian Forces Quick Don Immersion Suit NSN 8475-21-820-4601 used in the CP121 (Tracker), CP140 (Aurora) and CH124A (Sea King) aircraft.

INTRODUCTION

This report is comprised of two parts. The first provides a brief summary of the history of the cold water immersion problem and a description of the physiological process involved. The second section describes the efforts to develop a suitable replacement for the Canadian Forces' (CF) current quick don immersion suit.

BACKGROUND

The effects of accidental unprotected exposure to cold water immersion were scientifically investigated by James Currie in 1798; he theorized that death was caused by cold and not by drowning as was generally believed (13). So prevalent was the belief that all water fatalities were caused by drowning, that even as late as 1912 with the sinking of the Titanic in $0^{O}C$ water, the effect of cold as a contributing factor in the 1489 fatalities was not even mentioned in reports.

It remained until The Second World War for the commencement in earnest of serious cold water physiology research in order to design adequate protective clothing for military personnel. The most infamous experiments of this nature were performed upon concentration camp inmates at Dachau (13). In 1946, G.W. Molnar drew upon the Dachau data and the U.S. Navy wartime cold water exposure statistics to predict the probability of survival in water of various temperatures. He noted that body temperature will fall during exposure to water temperatures below $20^{O}C$ (5). In 1962 Barnett published a survival graph (Figure 1) loosely correlating water temperature and exposure time to "safe", "marginal (50% survival)", and "fatal (100% death)" outcomes. More sophisticated international studies since that time have confirmed that such "loose" survival curves cannot be relied upon due to the tremendous variability in factors affecting body cooling rate, the most significant being the degree of insulative protection worn.

In 1964, E.H. Wissler developed a mathematical model of the human thermal system that could be used to predict the insulative (clo) values of protective clothing worn to protect against cold water exposure (Figure 2). The resultant survival curves form the basis for the current Air Standardization Coordinating Committee - Air Standard 61/40 (14). Since that time, considerable work in this area has been accomplished by Dr. J.R. Allan of the Royal Air Force Institute of Aviation Medicine (RAF/IAM) in correlating the percentage loss of insulative value as a function of water leakage into dry immersion suits (1), and in 1984 Allan and Hayes produced an updated version of Wissler's curves (Figure 3). Recently P.A. Hayes and J.B. Cohen of IAM modified Wissler's curves (Figure 4) through the inclusion of " ... more advanced and accurate mathematical descriptions of the various physiological and physical processes involved", and they consider these curves " ... to supercede all previous published predictions" (3). As a result, a proposed amendment to ASCC AIR STD 61/40 was submitted by the RAF/IAM on 4 September 1987 to incorporate these latest survival prediction curves (10).

It is generally accepted by the scientific community that sudden unprotected immersion in cold water may result in death through two primary mechanisms: cold shock (sometimes referred to as hypothermia syndrome) and immersion hypothermia. Cold shock

can cause immediate death, especially in older less healthy individuals, and those with cardiac disease. The sudden overwhelming sympathetic effect of cold shock may kill outright by inducing ventricular fibrillation or by drowning following the "gasp reflex". The sympathetic gasp reflex may result in cold water aspiration if submerged. Following the gasp reflex there is an increase in the ventilation rate and a decrease in the ability to breath hold. This increased ventilatory drive in very cold water results in a fall of arterial carbon dioxide tension which may cause loss of consciousness and death by drowning.

The second mechanism, immersion hypothermia, is insidious but death is still the end result. This arises as a result of a progressive decline in central arterial blood temperature below 37°C with eventual nervous system paralysis and brain and heart failure (Figure 5). Body cooling commences when an inadequately protected individual is exposed to water temperatures below the thermoneutral point of 32.8°C (5). Cooling is very rapid due to the 20 fold higher specific heat of water over that of air. In addition, cold water exhibits a higher viscosity * than comparatively warmer water which makes swimming more tiresome. This is inherently dangerous since an individual may attempt to swim to shore as he normally could in warm water, only to flounder and drown from exertion within 100 yards of travel.

Following cold water immersion, the unprotected body depends upon two major physiological mechanisms to preserve body temperature: peripheral vasoconstriction to reduce tissue conductivity and therefore heat flux, and an increased heat production through shivering thermogenesis. Unfortunately, in water less than 20°C both are ineffective in arresting the progressive decline in central body temperature.

The vascular bed under the skin contains about 10% of the blood volume (13) which during vasoconstriction is returned to the systemic circulation. This sudden increase in circulating blood volume stimulates the volume receptors resulting in anti-diuretic hormone (ADH) suppression followed by an increase in urine production (diuresis). This cold water diuresis can result in a decrease in immersion suit protection following micturition in the suit. Paradoxically, it appears that in very cold water exposure (below 12°C) there is a loss of vasoconstrictive capability perhaps due to blood vessel paralysis, with spasmodic vasodilation and ensuing heat loss and core temperature drop.

Shivering may increase heat production levels to four or five times the resting value, or higher for short periods, to a maximum value which occurs in water temperatures between 15 to 20°C. The intensity of shivering appears to be proportional to the rate of skin cooling but is gradually suppressed as the body's core temperature approaches 35°C. Cessation of shivering is followed by a muscular rigidity at a core temperature of approximately 31°C. This rigidity lessens as core temperature continues to fall, and disappears about 27°C. Loss of consciousness precedes this event at about 30°C and can result in the drowning of those individuals without flotation devices. Hypotension, atrial fibrillation, metabolic acidosis, and hyperglycemia develop followed by loss of reflex activity around 27°C, with coma at 25°C and heart failure and death at or below 24°C (Figure 5).

The viscosity of water at 0°C is 1.787 centipoise (cp) and at 25°C it is 0.890 cp. This represents a two-fold increase in frictional resistance and therefore in swimming workload.

Immersion hypothermia remains one of the greatest hazards facing aircrew of CF maritime aircraft today and will assume greater importance if more operations are conducted in the Arctic in the future. The rapidity of response of search and rescue facilities will also assume a greater importance in influencing the outcome of water immersion following aircraft ditching or ejection. Water temperatures off the Canadian east coast average 0 to 15^{o}C in the summer and -2 to 5^{o}C in the winter. It is necessary that occupants of aircraft operating over water of this temperature range wear sufficient immersion protection clothing.

The CF currently provides the aircrew of Maritime Air Group (MAG) with either a constant wear, individually-tailored dry immersion suit or a quick-donning type dry suit (Figure 6). Quick don suits are carried on board the CP121 (Tracker), the CP140 (Aurora) and are issued to passengers on the CH124A (Sea King). Only the CH124A aircrew wear the constant wear suit during flight operations in consideration of their extremely low level over water role and attendant probability of water ditching without warning. MAG Order 205.2 specifies the immersion suit is to be worn by all aircraft occupants on over-water flights when the sea temperature is 13^{o}C or below, or whenever the sum of air and sea temperatures is less than 31^{o}C. Personnel who crew the Tracker and Aurora do not wear immersion protection during flight. Informal discussion with aircrew suggests that this stems from a belief that there will either be sufficient warning time prior to ditching for the quick don suit to be put on, or that inadvertent ditching is inherently fatal in which case immersion protection would be irrelevant.

In 1982, Brooks and Rowe (2) analysed CF water survival experience during the period 1962-1982, and concluded that 92% of all aircraft water ditchings were preceded by less than one minute warning, with 78% of the cases having less than 15 seconds warning. Based on the number of ditchings, the Sea King and Tracker were identified as being most at risk. Seventy-five per cent of the recorded Tracker water ditchings were non-fatal which indicates that these aircrew can expect to be faced with the problem of surviving water immersion until rescue. Since the study indicated there is no basis to believe that Tracker ditchings are inherently fatal nor that sufficient warning time may be available to don immersion suits prior to water entry, it was concluded that Tracker aircrew should wear a constant wear immersion suit.

The present CF quick don anti-exposure flying coverall (NSN 8475-21-820-4601) has been in use since the mid-60's (Figure 6). As a result of user complaints about inadequate protective capacity and escalating production costs, in October 1980 the Directorate of Air Requirements (DAR) requested that the Directorate of Aerospace Support Engineering (DAS Eng) " ... investigate (the) latest commercial and military developments, both domestic and international, in the field of quick donning immersion suits and determine possible suitability for use by CF aircrew" (11). In April 1981, DAR outlined the quality and performance standards required for the replacement suit (12). These are attached as Annex A to this report. Shortly after, DAS Eng tasked the Defence and Civil Institute of Environmental Medicine (DCIEM) " ... to survey and, if practicable, recommend a replacement item for the current quick don immersion suit" (8). This tasking was allocated to the Medical Life Support Division (MLSD) in May 1981 as DAS Eng 40.

DEVELOPMENT and TESTING

From 1981 to 1984, an extensive market survey was conducted and representative samples of immersion suits were obtained from various manufacturers, national and international. Physical and physiological parameters were evaluated for conformance to the DAR specifications. The results and recommendations were published in 1985 (4).

The Imperial Lightweight Prototype suit (ILWP) manufactured by Maritime Equipment Limited Canada, a division of Imperial Manufacturing (Bremerton, Washington), was recommended as the "most suitable" of those tested (Figure 7). However, it was also recommended that the suit should incorporate enhanced fire resistance, watertight integrity and manual dexterity. In particular, recommendations were made to incorporate:

a. a horizontal zipper closure across the chest from shoulder to shoulder. It is reasoned that a horizontal (vice vertical) zipper would be largely out of water during flotation with a lifepreserver and would help to minimize any possibility of leakage through the zipper closure or its seams;

b. a single rubber bellows-type neck seal and a simple, detachable, pull-over hood;

c. neoprene rubber wrist seals and detachable waterproof mitts;

d. flame retardant materials; and

e. some method of individually adjusting the suit to improve mobility within a "one size fits all" concept.

Mustang Industries (Richmond, British Columbia) was contracted to manufacture two prototype suits to conform to the recommendations of the DCIEM report. These suits (Figure 8) were received by MLSD early in 1986, and were successfully tested for ease of donning, leakage and fire retardancy properties in May 1986 (7). It was recommended that both the ILWP and Mustang prototype be evaluated in the field in order to determine the best configuration that would meet the needs of the CF. It was also recommended that the Quality Engineering Test Establishment (QETE) (Hull, Quebec) be tasked to study the effects of long term storage on the suit materials.

In August 1986, DAR issued a directive for the operational evaluation of the prototype immersion suits. In October, MAGHQ issued the project directive for the operational evaluation of the immersion suits as OPVAL/A999L and assigned the responsibility for the conduct of the trial to the Base Commander, Canadian Forces Base Shearwater (Nova Scotia). Specifically, the evaluation was to include an assessment of whether CP140 and CP121 aircrew could perform cockpit duties associated with controlled ditching scenarios while wearing the immersion suit, and whether all survival functions, such as boarding the life-raft, could be carried out wearing integral mitts.

In June 1987, an Interim Report on OVAL/A999L was received from HT406 Squadron (9). The evaluation concluded that:

a. neither suit interfered with emergency egress from the Tracker or Aurora aircraft;

b. neither suit interfered with the performance of flight duties consistent with controlled ditching scenario on either aircraft;

c. the Mustang suit did not degrade the ability to board life-rafts;

d. the ILWP suit created considerable difficulty in boarding life-rafts due to the poor manipulatability of the integral mitts;

e. the Mustang suit was compatible with all associated safety equipment; and

f. the integral hood and mitts of the ILWP suit interfered with the operation of safety equipment.

The report concluded that:

a. the ILWP suit is not acceptable as a replacement for the present suit primarily due to significant impairment of the ability to board life-rafts and incompatibility with operating safety equipment; and

b. the Mustang prototype in its present configuration is an acceptable replacement, although several modifications would enhance its' effectiveness. These modifications were recommended:

   i. incorporate straps for ankle suppression to reduce material bulkiness of the lower leg area;

   ii. incorporate a heavier boot tread on the soles to minimize inadvertent tearing; and

   iii. replace the chest-mounted zipper with a diagonal torso zipper.

It was also noted that although both suits are bulkier than the current CF quick-don, and would not fit into the storage compartments of the Aurora, the Aurora has sufficient spare storage space that no stowage problem was foreseen.

To define the design of a suit to conform to the recommendations of the OPVAL report, the MLSD Senior Project Officer met with DAR 3-2 and DAS Eng 4-3-2 in Ottawa in May 1987, then with the President and Vice-President of Mustang in Vancouver in June. It was decided that the Mustang suit would be pursued and that two design prototypes would be constructed for final selection procedures. Fabrication would be from 3mm closed cell polychloroprene (neoprene) foam, which is inherently petroleum, oil and lubricant (POL) resistant. The two designs were:

a. **Type 1 (Figure 9)** : incorporating a horizontal zipper, bellows type neck

seal, detachable mitts with rubber wrist seals, detachable hood with neck suppression, "tug-tight" waist suppression, zippered ankle suppression and intermediate weight boot tread; and

b. **Type 2 (Figure 10)** : incorporating a vertically diagonal zipper with split-neck seal, integral right mitt and detachable left zippered mitt with rubber wrist seal, velcro waist and ankle suppression straps, and intermediate weight boot tread.

It was envisioned that during the final evaluation process, the operators would be allowed to mix-and-match the best characteristics of each suit into one final acceptable design during the conclusion of OPVAL/A999L. Three copies of each of the two design types were fabricated for MLSD, and these were received in November 1987.

Both suit types were evaluated for donning and leakage problems in the DCIEM static tank. Both types could be donned without practice within 90 seconds. Each was subjected to a four foot jump into water followed by twenty minutes of vigorous splashing. It was quickly determined that the split neck seal concept was unacceptable in its leakage with over 75% of the undergarments surface wetted. The Type 1 suit exhibited minimal leakage at the end of each zipper wicking into the forearms, and leakage in both feet through seams. It was confirmed that the suits had not been leak tested prior to shipment from Mustang. As a result of these preliminary tests, MLSD rejected the split neck seal design and requested Mustang forward another suit, designated Type 3 for further evaluation. This suit, which arrived 30 December 1987, was intended to incorporate the best features of the Type 1 and 2 as well as the following additional improvements:

a. taped and glued seams;

b. velcro strap suppression at waist and ankles;

c. simple detachable hood;

d. simple detachable mitts;

e. rubber neck and wrist seals;

f. thinner hood and mitt storage pouches; and

g. thicker foot soles.

The Type 3 suit was leak-tested in the DCIEM static pool in early January 1988 in the same manner as the previous suits. No leakage was evident. The suit was capable of being rolled into a cylindrical storage pack of dimensions 9.7 inches in diameter and 19.5 inches in length, and was turned over to MAGHQ for evaluation on 13 January 1988. Subsequent evaluation by HT 406 Squadron (Shearwater) determined the inherent buoyancy of the suit to be approximately 27 pounds (120 N), which is within the limits set by the Canadian General Standards Board (16). In addition, MAGHQ requested NDHQ to investigate storage positions

on the CP121 and CP140 aircraft for storage of the Mustang suit due to its increased bulk over that of the current quick-don (17).

In early March, MLSD tested the insulative value of a variety of aircrew environmental and protective garmentry utilizing a thermal instrumented manikin. Testing was conducted at the CORD GROUP (Dartmouth, Nova Scotia) under Department of Supply and Services Contract W7711-7-1407/01-TOD. The Mustang suit was found to provide approximately 0.8 immersed clo protection when worn over the standard CF summer flight suit and lightweight long underwear. An analysis of the clo value of the current CF quick don was attempted but was unsuccessful due to the inability to don the suit over the manikin. However, a successful test was accomplished using a suit of similar material and construction and a value of 0.3 immersed clo was obtained. Using Haye's and Cohen's survival chart (Figure 4) based on mathematical modelling, the estimated survival times in 0^{o} C calm water for the Mustang and CF quick don (when summer flight clothing is worn underneath) respectively, are six hours and 1.5 hours. It would then appear that the Mustang Type 3 suit provides four times the protection of the current suit. It should be understood that the current CF quick don suit is designed to act only as a water barrier and provides little intrinsic insulative value. In contrast, the Mustang suit provides inherent insulation due to its three mm closed cell foam construction. This provides an additional bonus in that, should leakage occur and the undergarments become wet, a total loss of insulation value does not occur, whereas with the current CF quick don a similar situation could lead to a total loss of insulation protection. Unfortunately, the degree of thermal protection to be incorporated into the replacement suit was not specified in the "Replacement Specifications and Standards" (Annex A), and, therefore, a "design endpoint" was not established. At the Project Review Meeting held at DCIEM in June 1988, DAR 3-2 was requested to draft a Statement of Requirements to specify the degree of insulation required. The USN, USAF, and the CF ALSS programme have established insulative design criteria for their immersion suits. The suit ensemble must have sufficient insulative value to prevent central arterial blood temperature from falling below 35^{o}C under the following conditions:

a. 2 hours exposure to 7^{o}C water without a life-raft; and

b. 2 hours exposure to 0^{o}C water with a life-raft.

(The ASCC Standard (14) references insulative values to an arterial temperature of 34^{o}C.)

In April 1988, Air Command Headquarters authorized MAGHQ to task CFB Shearwater Safety Systems to bond a thicker sole to the Mustang Type 3 suit boot for passenger transit purposes, and CFB Greenwood Safety Systems to produce a suitable storage container for the suit and to ensure there was adequate storage locations on board the CP140 (Aurora). Additionally, CFB Summerside was tasked to assess storage available on board the CP121 (Tracker) (18). MLSD informed DAS Eng in May 1988 (19) that should stowage indeed be a problem, the high immersed clo value of the suit may allow for some reduction of fabric thickness (to 2 or 1 mm) which would reduce the bulk (and the insulative value and cold water survival time).

In November 1988, MAGHQ advised the MLSD project officer (20) that the Mustang

suit had been assessed at all levels as being the best available replacement for the current CF quick-don suit, and that MAGHQ recommended immediate action be taken to procure the Mustang suit for CP121 operations, as well as the modified suit incorporating a thicker sole for CH124 Sea King and CH135 Twin Huey operations.

CONCLUSIONS

The 3mm expanded neoprene foam quick-don immersion suit (Type 3) produced by Mustang Industries (Richmond, B.C.) offers a viable, effective replacement for the current CF quick-don immersion suit. This suit offers sufficient insulative value to keep an individual alive for up to six hours in $0^{o}C$ calm water when worn over standard CF flight clothing.

RECOMMENDATIONS

The Mustang 3mm expanded neoprene foam quick-don immersion suit should be considered as the replacement suit for the current quick-don suit used in CH124A Sea King operations. This suit could be introduced into the CF supply system on an attrition basis.

For CP140 Aurora and CP121 Tracker operations, an evaluation of a 2mm and a 1mm expanded neoprene foam suit should be conducted to assess insulative characteristics, predicted survival time in cold water, and storage compatibility within the confines of the aircraft.

NDHQ/DAR should establish a reasonable insulative "design-endpoint" standard for immersion suits based upon a realistic assessment of the threat of exposure of Maritime personnel to cold water (with and without life-raft) and the predicted time to rescue.

REFERENCES

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3. HAYES, P.A., J.B. COHEN; Further Development of a Mathematical Model for the Specification of Immersion Clothing Insulation; RAF/IAM Report 653, March 1987.

4. HYNES, A.G., et al; Evaluation of a Series of Quick-Don Immersion Garments for Selection of a Replacement to the Present Canadian Forces Quick Don Immersion Coverall (NOT TO BE RELEASED TO INDUSTRY); DCIEM Report 85-R-34; June 1985.

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8. Letter: 18415-116 (NDHQ/DAS Eng 4-3-2) 27 April 1981.

9. Letter: 3333-1 (BComd) CFB Shearwater, 10 July 1987; Project OPVAL/A999L Interim Report.

10. Letter: RAF/IAM IAM/1041/ASCC/61/114 4 September 1987; Change to ASCC AIR STD 61/40.

11. Memorandum: 18415-116 (NDHQ/DAR 3-2) 27 October 1980; Immersion Suits - Quick Donning.

12. Memorandum: 18415-116 (NDHQ/DAR 3-2) 14 April 1981; Immersion Suits - Quick Donning.

13. AGARD-AG-211; Survival and Protection of Aircrew in the Event of Accidental Immersion in Cold Water; February 1979.

14. ASCC AIR STD 61/40; A Technical Basis for Specifying the Insulation of Immersion Protective Clothing; 11 September 1984.

15. ASCC ADV PUB 61/55; Methodology for Assessment of the Thermal Performance of

Immersion Protective Clothing; 30 July 1986.

16. CAN/CGSB-65.17-M Helicopter Passenger Transportation Suits; Standards Council of Canada; 1986.

17. Message MAGHQ SSO ER 027 291410Z Jan 88.

18. Message AIRCOM SOAMS 22037 071400Z Apr 88.

19. Message MLSD 131 181545Z May 88.

20. FAX Message MAGHQ SSO ER dated 18 Nov 88.

Figure 1. Survival Graphs
developed from the data of Barnett (1962) for individuals in cold water

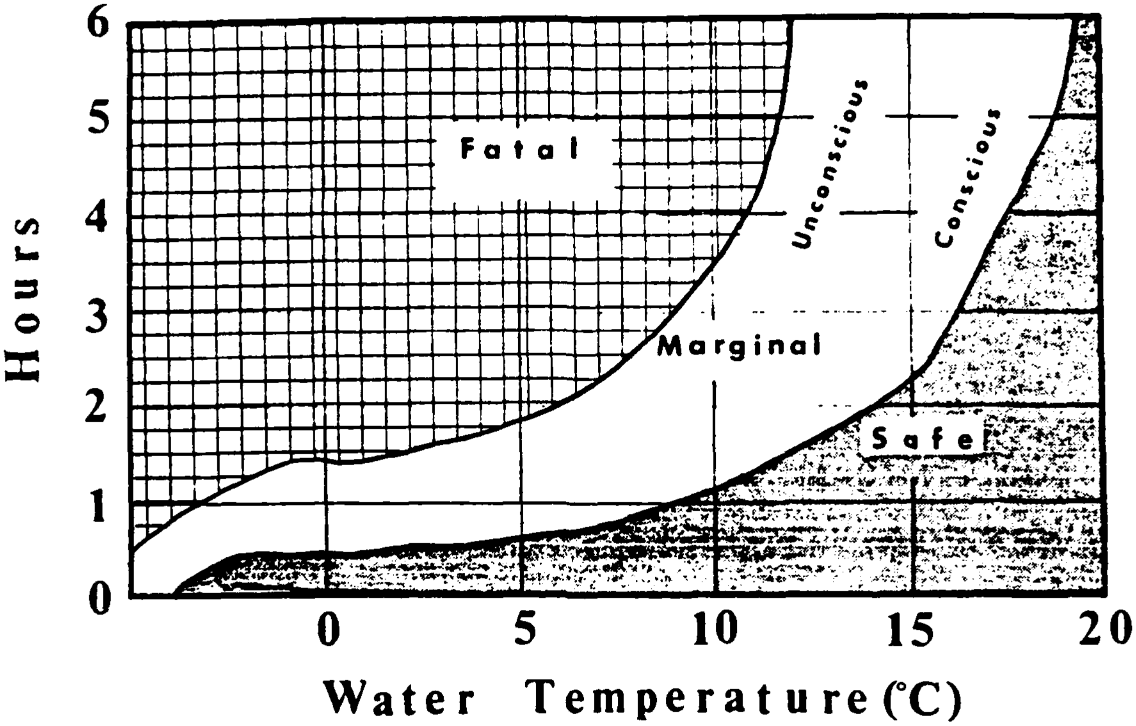

Figure 2. Survival Curves
developed by Wissler from modification of the mathematical model devised in 1964

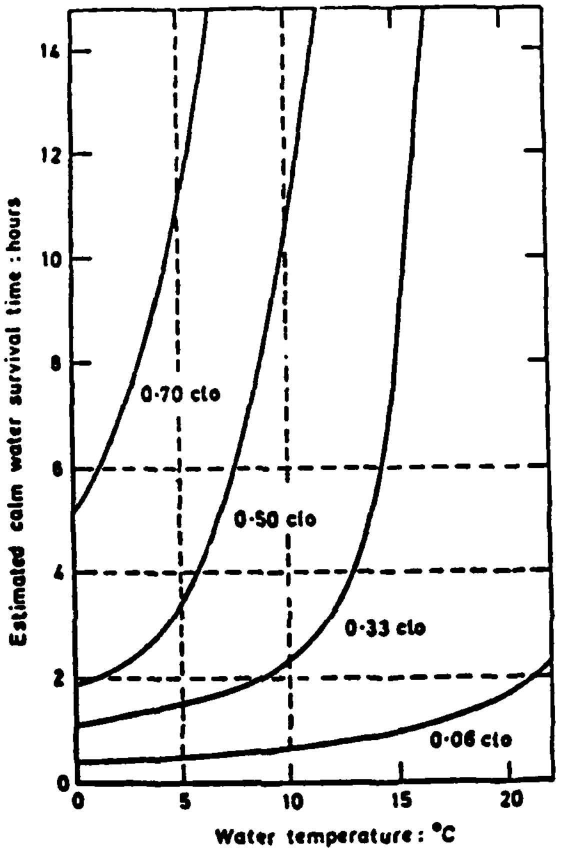

Figure 3. Survival Curves
developed by Allan and Hayes (1985) based upon a tenth percentile individual and the time for central arterial temperature to drop to 34° C in calm to slight sea states (using Wissler's mathematical model).

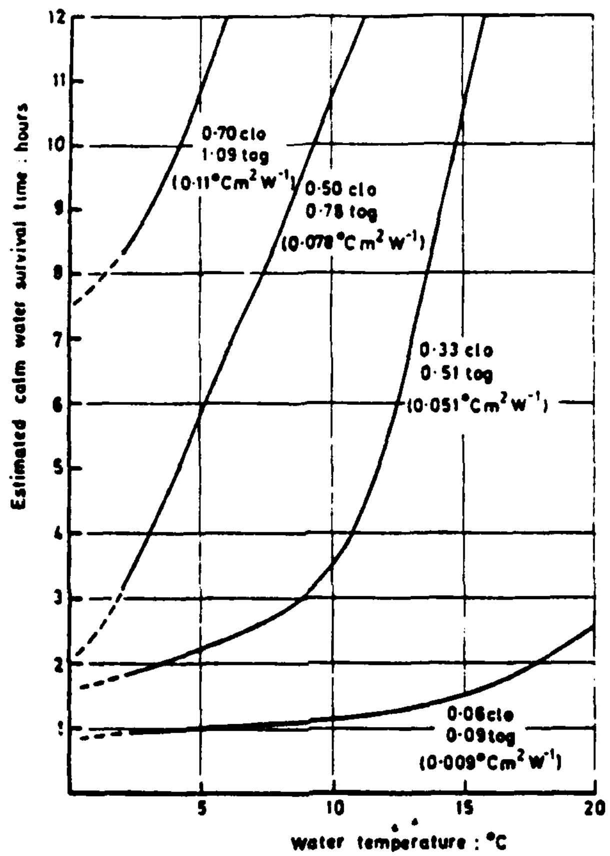

Figure 4. Estimated calm water survival time
for the 10th percentile man in water at different temperatures wearing four different clothing assemblies. The man is at rest with no leakage or urine loss when wearing a dry suit. Curves are corrected for counter-current heat exchange, the USAF six-site formula for mean weighted skin thickness, and shivering thermogenesis. After Hayes and Cohen (10) 1987.

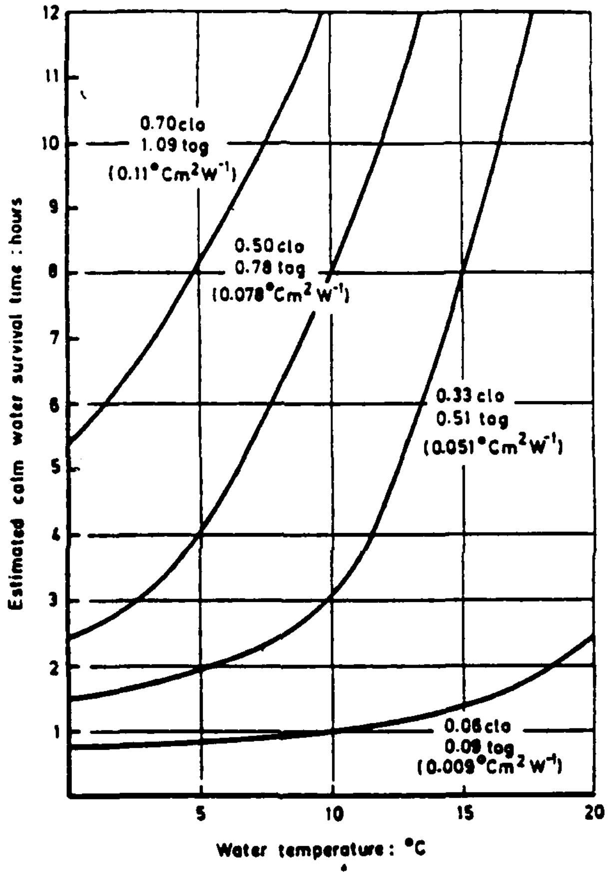

Figure 5. Physiological responses to decreased rectal temperature.

From the Newsletter of the Surf Life Saving Association of Great Britain, Autumn 1975, Issue No. 44. These diagrams were presented by Lt. John Blake, M.B.E., S.R.N., C.I., Royal Navy, Institute of Naval Medicine, Alverstoke, Gosport, Hants.

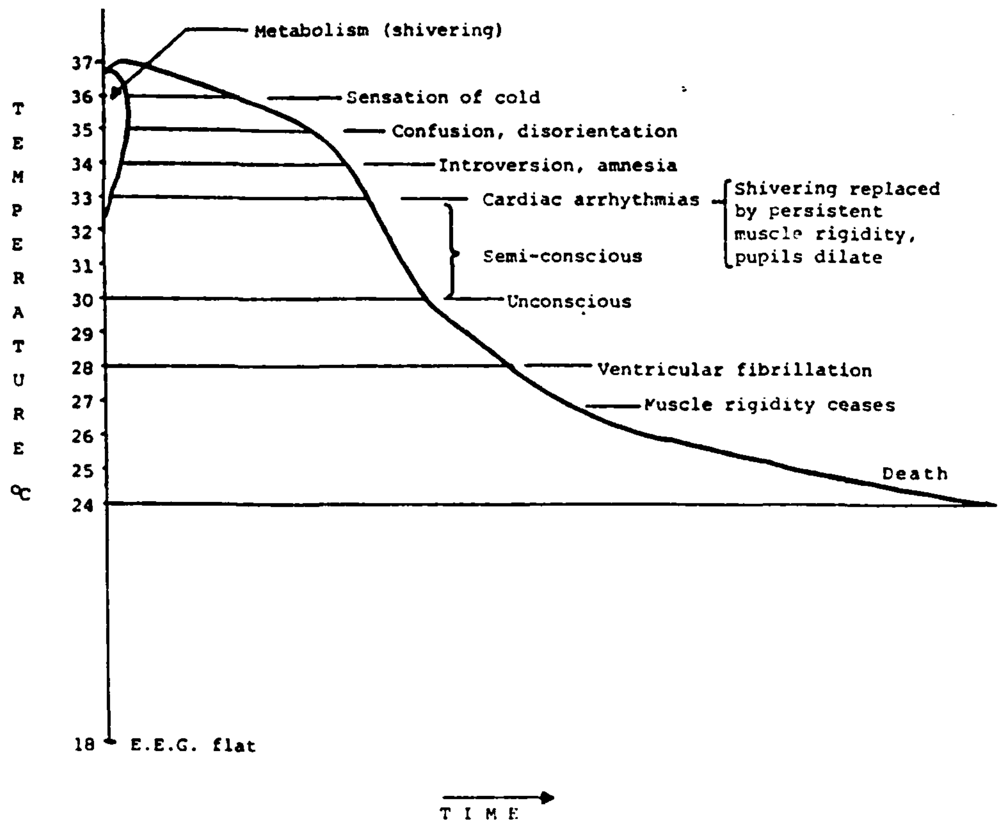

Figure 6. Current Canadian Forces Quick-Don Anti-Exposure Coverall
(NSN 8475-21-820-4601) in use since 1965.

Figure 7. Imperial Light Weight Prototype Suit
Integral hood, vertical zipper closure with split neck seal, integral rubber elbow mitts, taped and glued seams.

Figure 8. Mustang Quick-Don Prototype
Evaluated during OPVAL/A999L (Ankle straps depicted installed following OPVAL; original suit destroyed for fire retardancy testing.)

Figure 9. Mustang Quick Don Immersion Suit (Type 1)
Transverse zipper closure; detachable mitts and hood;
rubber neck and wrist seals; ankle and waist suppression.

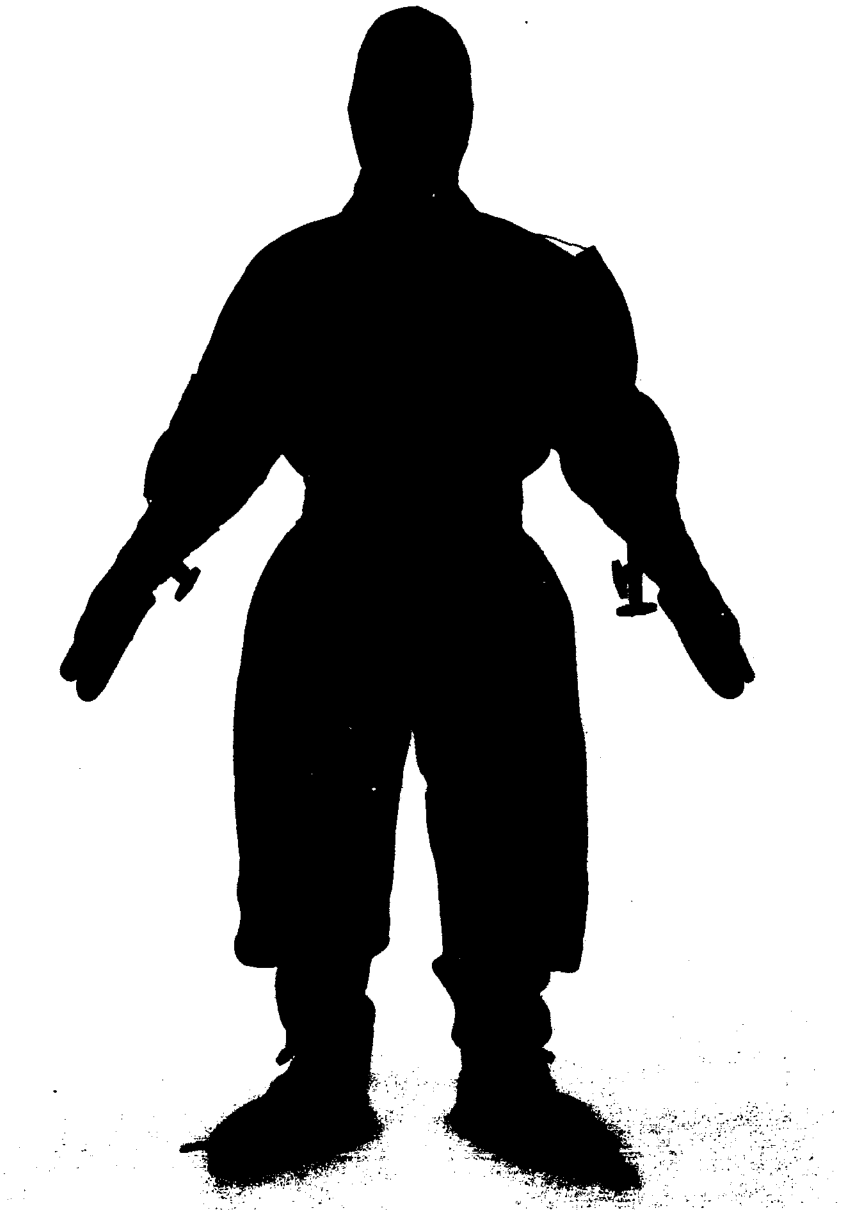

Figure 10. Mustang Quick Don Immersion Suit (Type 2)
Split neck seal resulted in excessive leakage and
was rejected by MLSD after pool trials.

MEMORANDUM

18415-116 (DAR 3-2)

14 Apr 81

Distribution List

ANTI-EXPOSURE COVERALL QUICK-DONNING
REPLACEMENT SPECIFICATIONS AND STANDARDS

Refs: A. MEETING AT DAS ENG 20 Mar 81
B. 18415-116 (DAR 3-2) 27 Oct 80
C. 14240-500 (DAR 3-2) 27 Jun 80
D. AIRCOM DCOS OPS 128, 252040Z Mar 80
E. UCR CFB COMOX D0133/0001 14 Feb 80

1. As discussed Ref A there is a definite requirement to seek replacement for the in-service quick-donning anti-exposure flying coverall (NSN 8475-21-820-4601). Refs C, D and E clearly indicate user dissatisfaction with our present coverall and suggest that alternative suits of better quality are now available at no increased and possibly reduced cost. The in-service quick-donning anti-exposure coverall has been in use since approximately 1965. The cost of this suit has escalated dramatically from $270 in 1975 to $820 in 1980. Usage rates have averaged 75-100 units over the past four years resulting in costs of 61-82K per annum.

2. The quality and performance standard in the replacement coverall shall meet and preferably exceed that of the in-service suit, specifically in the following areas:

a. thermal protection;

b. durability;

c. resistance to ripping and tearing;

d. integrity of material, design and workmanship;

e. resistance to corrosion, rot and sunlight;

f. fire retardancy;

g. resistance to deterioration in storage (including stowage on board aircraft); and

h. shelf life.

(2) DAS Eng 4
Yours.
DAS Eng
15 Apr 81

(3) DAS Eng 3-3 [illegible]

[illegible]

.../2

3. The physical characteristics required in the replacement suit shall provide the following:

a. head protection in the form of a hood capable of being worn and secured over the bare head or CF flying helmet;

b. hand protection;

c. foot protection which allows wear of issue aircrew footwear;

d. sizing capability to accommodate the 5 to 95 percentile range of the CF population;

e. a colour which does not attract sharks; and

f. capability for storage in existing stowage facilities on designated CF aircraft.

4. As operational aircrew protective clothing, it is essential that the replacement coverall have inherent characteristics which would:

a. allow for maximum donning time of three minutes;

b. not restrict field of view 60^{0} to left and right of centre when hood is up and fastened;

c. provide sufficient dexterity to allow performance of flying functions;

d. not unduly interfere with egress from designated CF aircraft;

e. not unduly degrade ability to board life rafts;

f. not negate righting properties of current CF flotation devices;

g. be compatible with related aircraft and other life support equipment; and

h. not create weight problem through water absorption. A suggested maximum is 25 pounds, either trapped or absorbed in one hour of continuous immersion.

5. The requirement, simply stated is to provide aircrew and passengers with enhanced anti-exposure protection through procurement of a replacement state-of-the-art quick-donning anti-exposure coverall. It is intended that the in-service suit be replaced on an attrition basis on those aircraft designated in CFS 2 scale B32-001.

.../3

6. You are requested, therefore, as follow-on to Ref B to accomplish the following:

a. investigate the price and availability of suitable anti-exposure suits through commercial and military agencies;

b. arrange for purchase and evaluation of suits which may meet our requirements; and

c. advise the results of these investigations in order that selection of the best suit available can be made through user trials.

7. DAR OPI is Maj D.P. Redekopp, 2-8844.

for L.A. Ashley
Col
DAR
2-5224

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1 May 81 DMCSD

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DEVELOPMENT OF A CANADIAN FORCES QUICK DON ANTI EXPOSURE IMMERSION SUIT

4. AUTHORS (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

STURGEON, WAYNE R. CAPT

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This report details the development and testing of anti-exposure immersion suits to replace the current Canadian Forces quick-donning immersion suit (NSN 8475-21-820-4601) currently used in the CP121 (Tracker), CP140 (Aurora) and CH124A (Sea King) aircraft. [illegible]

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immersion suit,
anti-exposure suit,
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